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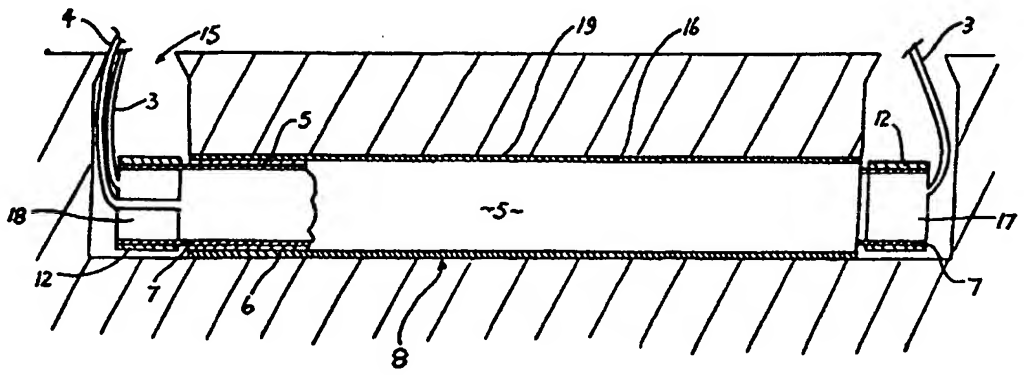
(54) Title: PIPE REHABILITATION



(57) Abstract

A method for rehabiliting existing pipelines in-situ is disclosed. A tubular liner (5) of a generally absorbent material is formed and at least one expandable bladder (7) is fed into the liner (5). The liner (5) is impregnated with a cold curable resin. The external surface of the liner and/or the internal surface of the pipeline (8) to be rehabilited is coated with a water resistant adhesive coating (16) prior to being fed into the pipeline (8) to be rehabilited together with its associated bladder (7). The bladder (7) is then inflated with a gaseous fluid to force the liner (5) against the internal wall (19) of said pipeline; and the inflation is maintained until the resin impregnated liner (5) has cured. The bladder (7) may then be removed from the cured liner (5).

use of steam/hot air to inflate bladder.

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PIPE REHABILITATION

TECHNICAL FIELD

The present invention relates to rehabilitating existing pipelines of various lengths and diameters and, in particular, to a method for performing such rehabilitation.

BACKGROUND ART

Underground pipe systems deteriorate over time as a result of degradation of materials and outside influences such as tree roots, compression from above, expansion and contraction and numerous other factors. In order to avoid the expense of excavating the pipes and replacing them a number of "in situ" rehabilitation techniques have been developed. Most of these systems involve lining internally the old pipe using a plastic liner which is fed into the old pipe via existing manholes or other existing access points. The liner is normally expanded into the required position against the internal wall of the existing pipe and cured to provide a rehabilitated pipe.

Known techniques typically use polyvinylchloride (PVC) liners which are hot-cured. The liner is fed into the existing pipe in a heated and softened form and then is further heated and expanded using pressurised steam to force the liner against the internal wall of the existing pipe. The steam is then replaced by pressurised air and the liner allowed to cool and cure while still being held firmly against the internal pipe wall.

Such systems have a number of disadvantages. They require expensive, specialised plant and equipment. For example, special semi-trailers, capable of carrying large industrial generators and compressors. The capital equipment may cost in the order of hundreds of thousands of dollars and is required by each crew to rehabilitate

each pipeline. Each pipeline may take of the order of 6-12 hours to complete. In view of the high capital equipment costs, duplication of capabilities is very costly, making response to market demands difficult.

Hot cure systems are also susceptible to shrinkage both longitudinally and diametrically. This can produce a number of problems including doubts as to the structural integrity of the pipeline. Longitudinal shrinkage may result in infiltration and blockages, particularly in respect of connections to branch lines. For example, where the liner shrinks after the connections for the branch line have been cut, the cut out portion of the liner may move further along the pipe wall resulting in infiltration through the liner. Further, movement of the liner with shrinkage may result in the liner moving across and blocking the branch connection.

It is also difficult to stop infiltration, or flow from a branch line during the rehabilitation process. This can result in the heated liner coming into con tact with a head of water. The water causes what is known as a "cold spot" in the hot cure method. This cold spot can inhibit the curing process which in turn leads to a failure of the line.

Often hot cure PVC liners do not expand beyond the diameter of the host pipe. This can result in an indentation not forming where the branch line connects to the mainline. This makes location of laterals and branches very difficult and time consuming. Further, hot cure PVC lines normally require their branch line connections to be cut using an expensive remotely operated internal lateral cutter. Hot cure PVC liners also normally require two access points to the host pipe.

Cold cure techniques are also known, most notably, a system using an inverted liner saturated with resin. The liner is turned inside out or inverted and then forced into

position in the pipeline by pressurised water normally produced by a static head of water in a vertical inversion tube or pressure vessel being fed into an open end of the liner. Though ambient or cold cure resins can be used with this system, thermo activated polyester resin systems are preferred.

DISCLOSURE OF THE INVENTION

The present invention seeks to overcome or at least ameliorate the above problems associated with the prior art by providing a cold cure method of lining existing pipelines in-situ.

According to the present invention there is provided a method for rehabilitating existing pipelines in-situ comprising the following steps:

a) forming a tubular liner of a generally absorbent material;

b) feeding at least one expandable bladder into said liner;

c) impregnating said liner with a cold curable resin;

d) coating an external surface of said liner and/or the internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating;

e) feeding said liner into the pipeline to be rehabilitated together with its associated bladder;

f) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and

g) maintaining said inflation until the resin impregnated liner has cured.

Preferably, the method includes the further steps of removing the bladder from the cured liner. In a preferred form, the liner is formed of a felt-like material. For

preference, the bladder is coated with a release agent prior to insertion into the liner tube. Preferably, the gaseous fluid is compressed air.

The resin curing time may be adjusted by adjusting the ratios of base resin and catalysts used. Further, where extended curing time is required, the resin may be cooled below ambient temperature during the set up process.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a pictorial representation of the liner prior to insertion into the host pipe;

Figure 2 shows a sectional representation of the liner and bladder prior to insertion into the host pipe;

Figure 3 shows a sectional part cutaway representation of the liner inserted into the pipeline.

Figure 4 shows a pictorial representation of the lining method where there is only a single access point and a boundary trap at one end.

MODES FOR CARRYING OUT THE INVENTION

Before discussing the process or method used in lining existing pipelines, an initial description of the materials used will be provided. The liner 5 is typically a felt-like material with a flexible coating 6 applied to the outside of the felt. Typically, the felt is formed from interlocked polyester with a thin membrane of polyurethane forming the flexible coating. It is tubed, stitched or vulcanised to form the shape of the pipeline. One or more extruded tubes 7 are coated with a release agent and inserted inside the felt

tube or liner 5 to form an inflatable bladder. The extruded tubes 7 are typically formed of PVC or other suitable plastics material although any form of flexible tubing capable of forming an inflatable bladder containing compressed air may be used. The inflatable bladder 7 may be inserted in the liner 5 before or after the felt is stitched or vulcanised.

The steps of a preferred method of lining an existing pipeline 8 will now be discussed with reference to the accompanying drawings. Firstly, the pipeline 8 to be lined is surveyed to access the length of pipeline to be lined and the location of any relevant junctions. These junction distances are then marked on the liner 5 and a thin flexible additional piece of tubing 9 is attached to the liner 5, as best shown in Figure 1. This additional tubing 9 is optional, but desirable, in that it prevents excess resin impregnating the liner 5 from bulging into the junctions and also assists in the cutting of the junctions once the liner 5 is cured.

The liner 5 is next placed in a straight line on the ground and air plugs 10, 11 inserted into each end of the inflatable bladder 7. A short piece of tubing 12 is placed over the end of bladder 7 adjacent the air plug 10, 11 and the air plug 10, 11 is inflated to retain the bladder end 13 between the air plug 10, 11 and the short piece of tubing 12. Air is supplied to the air plugs by air line 3 and to the bladder 7 by air line 4. The end of the bladder 13 is spaced from the end of the liner 14 to prevent the end of the liner being retained. The liner 5 is then inflated through one or both of the air plugs 10, 11. The liner 5 is inflated sufficiently to form the desired shape of the pipeline 8 to be relined. Once this is done both air plugs 10, 11 are pulled in opposite directions so as to stretch the bladder 7 within the felt liner 5. This process eliminates any ridges. The air plugs 10, 11 are then deflated and removed. The bladder 7 is also deflated.

A cold cure resin is then mixed and introduced between the bladder 7 and the felt liner 5 such that the resin impregnates into the liner material. The liner 5 can then be winched into position within the pipe 8 to be rehabilitated. As it is being winched into position through an access hole 15, a water resistant adhesive coating 16 is applied to outer flexible coating 6 of the liner 5. This water resistant coating 16 helps prevent infiltration in the rehabilitated pipe 8.

Once the liner 5 is winched into the correct position within the pipe 8, a blank air or mechanical plug 17 is inserted in one end of the liner inside the bladder end and a flow through air plug 18 is inserted in the other end of the bladder in the same manner. The bladder 7 is then inflated using compressed air. Once inflated, the bladder 7 may be stretched to remove any ridges. A number of deflated bladders 7 may be used inside the liner 5 as a form of security. Should the outer bladder fail through bursting or fails to hold pressure for any reason, then the air plugs 17, 18 are easily removed and inserted into a spare bladder.

The resin is then allowed to cure for the required time. During the curing process, the liner 5 is held against the inner wall 19 of the pipeline 8 by the pressurised bladder 7. The liner 5 is also attached to the inner wall 19 by means of the water resistant adhesive 16 previously applied. Following completion of the curing process, the plugs 17, 18 are removed and the internal bladder 7 removed after deflation. Preferably, the bladder 7 is attached to a cable which rotates the bladder tubing 7 while withdrawing it from the liner.

Once this stage is completed, the junctions can be cut internally by use of a remote control lateral cutter working in conjunction with a closed circuit TV (CCTV) camera.

Alternatively, an electric drain cleaner can be used externally to cut the junctions from relative access points.

Where there is only one access point to the pipeline 8 to be relined, the liner 5 is pushed into position with hand rods or other suitable means. The remote ends of the bladder 7 are sealed to prevent escape of inflation air and a flow through plug 18 is inserted into the accessible end of the bladder 7. The process is then performed in a similar manner to that described above.

In the case, where the only other access to the pipeline is a boundary trap, the method according to a further aspect of the present invention includes introducing a CCTV camera through the boundary trap to monitor and ensure correct positioning of the liner in the pipeline. This is shown in Figure 4. The liner 5 has one end 20 sealed. This end 20 is pushed toward the boundary trap 21 using hand rods (not shown) or the like until the CCTV camera 22 shows that the liner 5 is correctly positioned within the pipeline 8. The liner 5 can then be inflated using the internal bladder 7 in the usual manner through the accessible end via flowthrough plug 18.

It will be understood that the present invention overcomes or at least ameliorates the problems of shrinkage by use of an adhesive between the liner and the pipeline as well as a cold cure technique. Further the cold cure technique enables long lengths of pipe to be rehabilitated without the use of expensive, sophisticated equipment.

It will be appreciated that further embodiments and exemplifications of the invention are possible without departing from the spirit or scope of the invention described and the invention is not limited to the particular embodiments described.

CLAIMS:

1. A method for rehabilitating existing pipelines in-situ comprising the following steps:

a) forming a tubular liner of a generally absorbent material;

b) feeding at least one expandable bladder into said liner;

c) impregnating said liner with a cold curable resin;

d) coating an external surface of said liner and/or the internal surface of the pipeline to be rehabilitated with a water resistant adhesive coating;

e) feeding said liner into the pipeline to be rehabilitated together with its associated bladder;

f) inflating said bladder with a gaseous fluid to force the liner against the internal wall of said pipeline; and

g) maintaining said inflation until the resin impregnated liner has cured.

2. A method according to claim 1 including the further step of removing the bladder from the cured liner.

3. A method according to claim 1 or claim 2 wherein the liner is formed of a felt-like material.

4. A method according to claim 3 wherein the felt-like material is formed from interlocked polyester with a thin membrane of polyurethane forming a flexible outer covering.

5. A method according to claim 1 wherein the bladder is coated with a release agent prior to insertion into the liner tube.

6. A method according to claim 1 wherein the gaseous fluid is compressed air.

7. A method according to claim 1 including the step of cooling the resin impregnated liner below ambient temperature prior to step (e) to lengthen the curing time of the resin.

8. A method according to claim 1 including the step of reinforcing the regions of the liner which, in use, coincide with junction points along the pipeline.

9. A method according to claim 1 wherein the pipeline to be rehabilitated has access at one end for feeding in of said liner and the only other access to the pipeline being a boundary trap, the method including the step of introducing a TV camera through the boundary trap to monitor and ensure correct positioning of the liner in the pipeline.

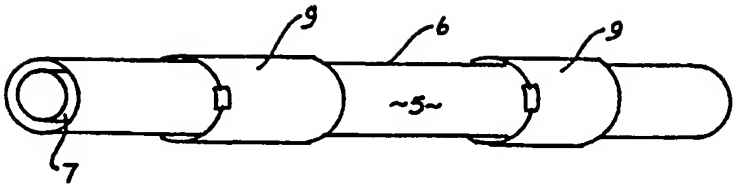

Fig. 1

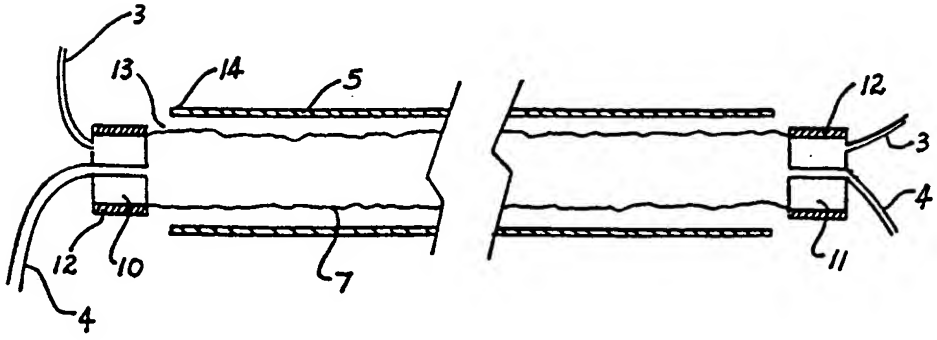

Fig. 2

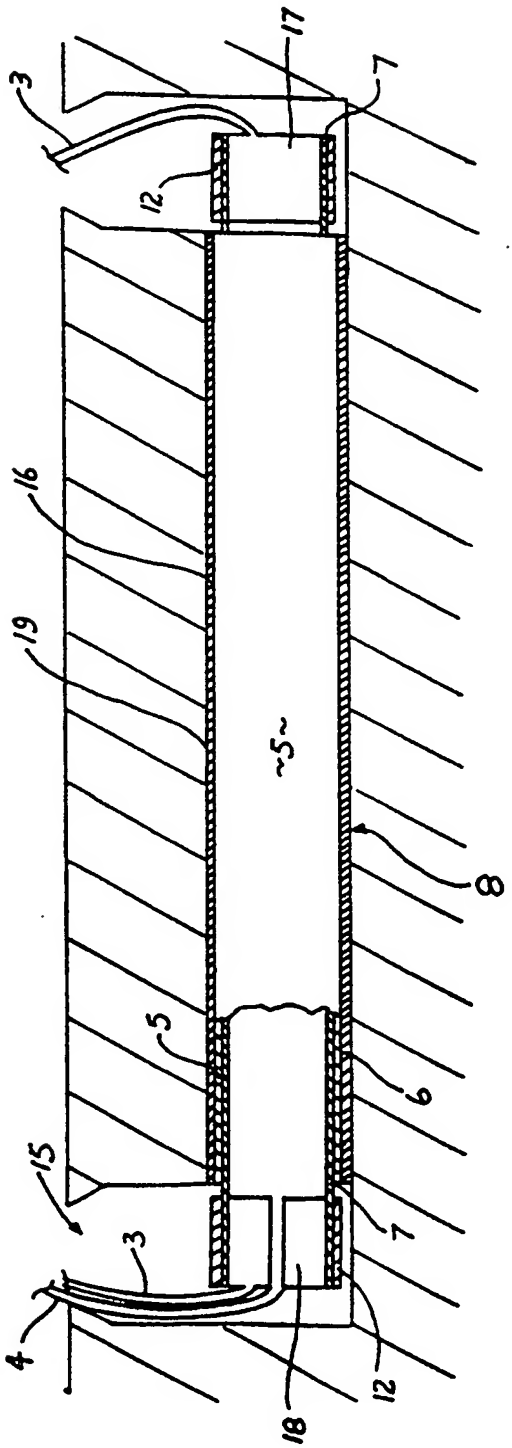

Fig. 3

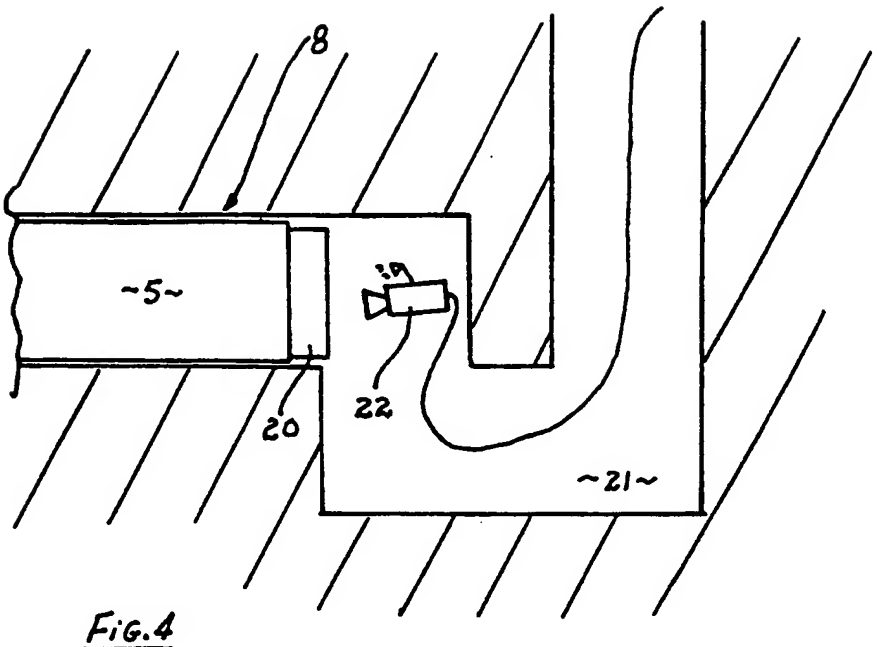

FIG.4

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00538

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: F16L 55/165

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC F16L 55/16, 55/165

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	AU 16378/95 A (CANT) 19 October 1995 Whole description	
A	AU 34611/93 A (INSITU FORM GROUP LIMITED)19 August 1993 Whole description	
A	AU 37197/89 A (MULLER) 25 January 1990 Whole description	

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
26 September 1996	24 OCT 1996
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929	Authorized officer **G.M. COX** Telephone No.: (06) 283 2484

INTERNATIONAL SEARCH REPORT

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C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AU 26650/88 A (STEPHENS) 8 June 1989 Whole description	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
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This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
AU	16378/95	CA	2146721	EP	676579		
AU	34611/93	EP	626052	FI	942550	NO	941763
		WO	9316320				
AU	37197/89	DE	3906057	EP	351570	JP	2248797
		US	5029615	AU	47832/90	DE	3937478
AU	26650/88						

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